

Three Virus Diseases of the Peach in Michigan

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THREE VIRUS DISEASES OF THE PEACH IN MICHIGAN

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Three virus diseases of the peach, peach yellows, little peach, and red suture, are known to occur in Michigan. The first two have exacted their toll of peach trees for years, while red suture has lately become important throughout the western Michigan peach belt. Two other virus diseases found in certain southern states but not in Michigan are peach rosette and phony peach.

In most years, these diseases spread to only a small percentage of the trees in an affected district if rigid inspection and removal is followed. In certain sections, the disease thus has been almost eliminated. Some seasons, however, may be designated as epidemic years in which these diseases spread with unusual rapidity. In such years, losses of 25 per cent are common and in some districts entire orchards are destroyed.

Early recognition of the symptoms and prompt removal of the affected trees are the only known methods of combating these diseases. Peach yellows was greatly feared until the early symptoms were recognized and prompt removal practiced. Today, because peach yellows is more generally known and so is more easily detected than the other two diseases, it is less prevalent in Michigan than little peach and red suture, neither of which are as familiar to the average grower. A recent rapid increase of peach virus diseases now commands the renewed vigilance of peach growers.

Nature of Virus Diseases

Virus diseases of plants differ from parasitic (biological) and non-parasitic (physiological) diseases in that no organisms have been definitely proven to be connected with these diseases, yet they are contagious and may be transmitted from diseased to healthy plants by means of an infectious principle or virus in the plant juices. Some virus diseases of plants may be transmitted by direct injections of plant juices from diseased plants, others are known to be transmitted from plant to plant only by means of insects, mostly of the sucking type, such as aphids and leaf hoppers. Evidence is still lacking of the transmission of peach virus diseases by insects, although this method of natural spread seems a most likely explanation. Transmission of yellows, little peach, and peach rosette has been artificially accomplished only by budding or grafting from stem or root; red suture transmission, so far, has been attempted only by grafting tissue from above ground parts of a diseased tree, while phony peach can be artificially transmitted only by grafting tissue from the roots of diseased trees to the roots of healthy ones.

Evidence presented from time to time by other workers shows that these diseases of the peach are not spread by pruning tools, pollen, or pits from diseased trees. Although direct proof is lacking of the agency of spread in the orchard, these diseases are highly contagious and under certain conditions are known to spread like wildfire if infected trees are not promptly removed.

History of Peach Virus Diseases in Michigan

Peach yellows made its appearance in the state about 1863. It started in Berrien county and soon spread through the peach growing counties in western Michigan, eventually reaching every peach growing community in the State. Duplicating the experience of other infected peach sections in the United States, peach yellows became epidemic in various localities every 10 to 15 years, causing serious losses well above the usual percentages.

Little peach was discovered almost simultaneously in Michigan, New York, and eastern peach growing sections about 1893. Since that time, it has been continuously destructive. Within the past few seasons inspectors report five times more little peach than peach yellows in Michigan orchards.

Red suture, seemingly a disease peculiar to Michigan peach districts, was probably first called to the attention of fruit growers by Taft (2) in 1911 who described it as follows:—"During the last year or two a disease has been noticed which, although it resembles Little Peach, differs from it in at least one important characteristic. While in Little Peach the fruits, which have stopped growing when the size of a large peach pit, do not soften and ripen until after the normal time, if at all, in the cases referred to the fruit not only softens but it apparently ripens prematurely, although neither the tree nor fruit show any of the characteristics of Peach Yellows.

"The fruit somewhat resembles that on trees injured by borers, but the leaves are like those on trees attacked by Little Peach, except that they seem somewhat mottled, green and yellow. The disease, whatever it may be appears to kill the trees within three years and should be treated as a dangerous one."

The symptoms of red suture were more fully described by Bennett (1) who began the first detailed investigation of the disease and gave it the present name. Bennett inoculated healthy trees with buds from diseased trees and reported that the inoculated trees did not produce symptoms the following year. However, these trees produced typical red suture fruits four years after budding and these fruits are now preserved as specimens in the Botany and Plant Pathology Department. It is not known that the trees showed the disease previously as records of other inspections are not at hand. A similar series of bud inoculations by Wedgeworth (3) in August, 1929, reproduced typical symptoms of red suture two years later, September 1931. Surrounding trees remained normal. These experiments proved that this disease can be transmitted by budding in a manner similar to peach yellows and little peach. The symptoms produced in the inoculated trees are typical of red suture, which indicates that this is a distinct disease and different from peach yellows and little peach. The exact relationship between red suture, little peach, and peach yellows is not definitely known.

Red suture was found in VanBuren, Allegan, and Berrien counties in 1926. In 1931, the disease was prevalent not only in those counties but in addition it was found in 30 per cent of the trees in one orchard examined and was reported generally serious in many other orchards of Kent county. Specimens showing the symptoms of this disease were also received from Ottawa, Muskegon, Oceana, and Mason counties. Many orchards examined by the writer in Allegan county in September, 1931, showed high percentages of red suture disease. Affected trees ranged from 5 to 100 per cent, although only a few orchards showed extremely high percentages of infection.

The large number of infected orchards and high percentage of infection in 1931 is probably due to a number of factors. As there was generally no fruit in 1930, the most reliable symptoms were not apparent. Foliage symptoms were confusing because of severe borer, drought, and winter injury of the past seasons. Growers, in general, not recognizing the disease have failed to eradicate affected trees and red suture has now gained a foothold in many orchards.

Symptoms of the Peach Virus Diseases Found in Michigan

Trees affected with any of the so-called virus diseases exhibit characteristic symptoms. In advanced stages the diseases are easily recog-



Fig. 1.—One main limb of this tree had peach yellows. The arrows point to sprouts at the base of the larger branches. A somewhat similar sprouting or feathering often accompanies little peach or red suture.

nized but trees in the initial stage often exhibit only faint indications. Not all of the typical symptoms of a disease are always present. The most reliable and often the first indications of these diseases are seen in the characteristics of the fruit, because foliage symptoms which usually accompany the disease may not be apparent.

Symptoms of Peach Yellows

In peach yellows, the fruit ripens prematurely, from several days to six weeks in advance of normal. Red blotches appear on the skin and are often associated with red streaks extending into the flesh radially toward the pit. The flesh around the pit may also be abnormally red. Premature ripening is the most characteristic symptom of this disease. Another fairly constant characteristic of peach yellows is the tendency of the leaf to fold together lengthwise along the midrib, giving an eavestrough or "V" shaped appearance. The midrib further bends downward and inward giving a claw-like or hooked appearance. A similar infolding may occur on normal leaves during a drouth or following borer injury but in the latter case, the leaves are droopy and flaccid. In peach yellows, they are more turgid and brittle.

Peach yellows foliage is usually paler than that of normal trees growing under the same conditions. On highly fertilized trees in the initial stages of the disease, only prematurely ripened fruit may be present and foliage may be normal in color. In well advanced cases, the yellow color of the foliage is usually outstanding.

Slender wiry shoots often sprout from the main branches. These assume an upright growth even when they originate from the side or under side of a branch. These "wire shoots" have small, narrow, willow-like leaves of a pale yellowish green color. Water sprout growth is more slender than normal and is usually branched into a brushy, broom-like growth. This characteristic growth is found occasionally on the terminals of the main-shoots.

Symptoms of Little Peach

Little peach in many cases shows reduced size and delayed ripening of the fruit as its most outstanding symptoms. Bennett (1) observed for Michigan conditions, however, that this and other symptoms of this disease in many instances are far from being characteristic of this trouble as usually described in the literature, and that leaf and twig characters were more uniform than fruit symptoms. Bennett's description may be summarized as follows:—"Tree often somewhat stunted, with pale yellow leaves and a more compact bushy appearance to the tree. The centers instead of being somewhat open are usually filled with shoots covered with clusters of leaves and short lateral branches. The terminal growth of the main limbs in advanced cases is also of this general type.

"Fruits ripen from a few days to three weeks late. They are reduced in size sometimes but at other times are full size and ripen only a few days late. The flavor is usually poor but frequently fruits of good quality are produced on affected trees. The Gold Drop seems to show the greatest delay in ripening and most marked reduction in size. Diseased Rochester fruits have shown less reduction in size and ripen-

ing is delayed not more than four or five days. Fruits from diseased Rochesters often have a fair flavor."

Observations in 1931 showed that in the initial stages of the disease the foliage is a deeper green than normal. These large, dark green leaves near the terminal shoots show a drooping (not wilting) appearance and lie closely appressed and almost parallel with the shoots from which they originate. The petioles or stems do not hold the leaves out perpendicularly from the branch as is the tendency in normal trees. The off-color stunted leaves are found only in advanced stages. A condition in which short shoots and leaf clusters spring from the basal portion of the main limbs (sometimes described as feathering or fuzziness) often accompanies the disease. A distinctive clustering and curling of the foliage is evident in many cases after the disease is well established.

The downward curl of leaves on trees affected by little peach consists of a bending of the midrib downward and inward although the halves of the leaves do not usually fold together as in yellows. The petioles or stems of the leaves are often twisted and bent in such a manner that the leaves do not lie in their normal well ordered arrangement.

Symptoms of Red Suture

Red suture disease is most apparent at ripening time. The most outstanding and characteristic symptoms of the disease are seen in the fruits. These ripen several days prematurely, one side of the peach, usually the suture or crease side, softening first. The peach itself may have a bumpy or rough contour, with heavier ridges usually running lengthwise with the suture, or the ridge of the suture may be abnormally raised. The bumps on the fruit may at times be almost warty. Affected fruits usually show an abnormal deep red to purple blush over the exposed side, and the color is deepest on the apices or peaks of the ridges.

The prematurely ripened side of the peach is abnormally watery and sometimes of a water soaked appearance. The entire fruit when gripped and squeezed firmly in the palm of the hand is easily crushed, and juice flies from the softened side. A normal peach of the same age will not be crushed or exude juice under ordinary pressure. Fruits from affected trees are frequently insipid to bitter in taste but are usually better in flavor than those from trees affected by yellows.

When red suture is apparent in the fruit, the entire tree usually presents a yellowish green or bronzed appearance. The tip, on many leaves, especially those that are twisted slightly downward, is of a lighter color than the remainder of the leaf. The smaller leaves of a cluster are also often of a lighter color. In advanced cases, there is a distinct curving downward and inward with a twisting of the petiole on an occasional leaf which throws the leaf parallel to the stem. Curving and twisting of the leaves is somewhat different for each variety of tree. Terminal growth is usually shorter than normal. Leaf clusters often sprout from most of the buds on a branch, and an unusual number of short shoots arise along the main branches toward the base. These shoots have shortened internodes, spaces between the leaves or buds, and are of small diameter but are not long and wiry as in yellows. Such shoots, together with the abnormal number of leaf clusters

sprouting on the main limbs near the center of the tree, give the characteristic symptom described as "feathering" or "fuzziness" and this is not unlike a similar condition sometimes found in little peach.

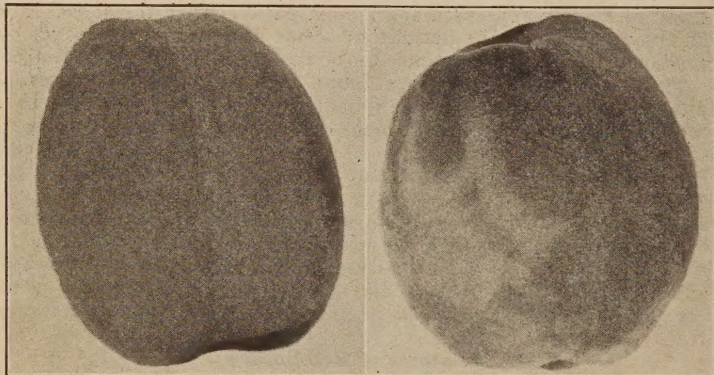


Fig. 2.—Fruits from adjacent Elberta trees. Peach at right shows marked symptoms of red suture. Note rough contour. The shading is caused by a deep red color over the suture and by darker color on the ridges.

Comparison of the Three Diseases

An opportunity for comparing these three diseases was possible in 1931 due to previous inoculations made in the College Orchard by Wedgeworth in 1929 (3). Each row of 20 trees in this orchard consisted of four trees each of five varieties, namely, Gold Drop, Elberta, *Hale, South Haven, and Rochester. The 20 trees in row two were inoculated with red suture buds taken from a tree near Kibbie, Michigan. Likewise, 20 trees in row 4 and those in row 6 were inoculated respectively to yellows and little peach. The yellows buds were obtained on the College campus from a Gold Drop tree which showed an abundance of willow-leaf symptoms. The little peach buds were obtained from an adjacent tree which showed typical symptoms of little peach. The orchard was planted in the Spring of 1927 and the bud inoculations were made in August, 1929. A majority of the diseased buds failed to sprout but tissue union was established.

In 1930, there was no crop and inspection showed no evidence of these diseases in the orchard. In 1931, the infections became evident. Early in August, row 4 showed decided symptoms of yellows in most of the trees in the row. The trees were visibly stunted, the foliage was decidedly more yellow than adjacent normal trees and the leaves showed the folding or rolling inward characteristics of yellows. The fruit of all the varieties in the row ripened at about the same time. Only the Gold Drop and Rochester showed extreme tendency toward "wire-

*There has been some discussion as to whether these Hale trees are true to varietal characteristics as the fruits appear to be more like Elberta.

shoot" and "willow-leaf" symptoms while Elberta showed faint signs of these symptoms. South Haven and Hale showed fewer foliage symptoms of the disease, although the fruit ripened prematurely. A few fruits on one Elberta tree showed a very faint tendency toward bumpiness as is found in red suture. The fruits on South Haven trees showed red blotches on the skin and some red streaking in the flesh but the red streaked flesh was not noticed in Gold Drop, Elberta, or Hale. This character was not recorded for Rochester, as the yellows affected fruits had fallen to the ground when the records were taken.

On August 28, the trees in Row 2, which similarly had been budded to red suture, appeared normal to the writer. Row 6, similarly budded to little peach, however, showed first symptoms of that disease. Diseased trees were not as apparent as were the yellows trees in Row 4. None of the little peach trees showed yellow foliage. However, they were, if anything, a deeper green than normal. In general, the affected trees showed the disease by slightly smaller fruits and appressed or drooping, denser foliage toward the ends of the main terminals.

Often the disease was apparent in only a single branch (in these cases on the south side of the tree where the diseased buds were originally placed) the rest of the tree being normal. This was in contrast to the yellows trees on which most branches were visibly diseased with only an occasional normal branch. As the season progressed, the little peach symptoms became more pronounced. In the following season, June, 1932, every tree in Row 6 which showed symptoms in 1931 was distinctly diseased and showed unmistakable evidence of little peach, as it is usually described. At that time, the trees were distinctly off color, leaves were smaller than normal, and beginning to show the characteristic curving downward.

Records of the trees in Row 2, inoculated to red suture, were again taken on Sept. 19, 1931. At that time, the foliage of the diseased trees in the row was off color, although the difference between that of red suture and normal trees was much less marked than was the foliage difference between normal trees and those with peach yellows. The foliage of red suture trees generally was slightly bronzed or yellowish green in color. In these trees, evidently producing the initial symptoms of the disease, color was the principal differentiating characteristic (aside from the fruit characters) as shoot growth and leaf twisting symptoms were not evident at this time. Fruit symptoms, however, were typical of the disease.

Fruit records were not obtained for Rochester and South Haven varieties as these trees had been picked almost a month previous. At picking time, none of the fruit from these two varieties had been considered diseased by the pickers and was marketed as normal fruit. Three South Haven trees showed distinct bronze color of the foliage in mid-September but few symptoms were apparent in the Rochester foliage as these trees were severely wind whipped.

Hale and Elberta peaches were prematurely ripened by several days and about half of the fruits on affected limbs were rough, ridged on the suture side, and colored an intense deep purplish-red over the ridges. The color was more evenly distributed or "washed" over the surface whereas the abnormal red in the yellows fruits appeared in blotches. In no case was the flesh beneath the skin flecked with red. Many of

the fruits were smooth over the suture but all were characteristically soft or ripe on the exposed side of the peach. Gold Drop fruits showed rough, or ridged sutures accompanied by premature ripening but were without red coloration that usually accompanied this character on Elberta or Hale.

Later in the season, October 22, 1931, it was noticed that more foliage had dropped from red suture trees than from normal trees, although the remaining foliage on the red suture trees had a comparatively healthy color.

Red suture trees could not be distinguished from normal trees at the beginning of the 1932 growing season but in early to mid-June they were all faintly off color and many showed a "feathering" or growth of sprouts at the base of the main limbs. The normal trees at this same date were in a stage of rapid growth and showed a healthy green color. Several weeks later when the growth of normal trees was naturally checked by weather conditions the color difference was not quite as apparent. Trees of the Rochester variety at this time showed marked stunting of the leaves and marked bronzing symptoms on the foliage, while symptoms on the South Haven variety were scarcely noticeable. Elberta, Hale, and Gold Drop showed less striking symptoms than those of the Rochester variety but to a greater degree than South Haven.

Diagnosis and Control of Peach Virus Diseases

The three virus diseases found in Michigan are readily identified in properly managed orchards which are in a good state of vigor. The symptoms are less readily recognized in neglected trees or those subnormal in vigor and are easily confused by the uninitiated with those symptoms caused by girdling due to mice, borers, or winter injury or to injury caused by black heart, wet feet, or malnutrition. For example a number of trees in one orchard was thought by the owner to have little peach when the trouble was found to be due to winter injury at the crown. The trees were left in the ground for another season and although they showed no evidence of little peach the following year, they were nevertheless unprofitable and worthless. There are now to be found in many Michigan orchards, numbers of trees which are subnormal due to winter injury at the crown, drouth, lack of borer control, or other causes. Most of these trees are past redemption and should be replaced by young trees as a matter of good business. New peach trees can be grown cheaper and more quickly than old trees which are injured by borer attack, winter injury at the crown, or black heart can be rejuvenated.

There is only one method of peach virus disease control. This is an early recognition of the symptoms and the prompt use of the axe. Several examinations are necessary each season at those times when the symptoms are apparent. Symptoms of well established cases will show in early June when normal trees are making their most vigorous growth. Newly developed cases are often first apparent at ripening time.

When in doubt remove the suspicious tree. The inspector can usually differentiate between the symptoms of a true virus disease and the symptoms produced by other causes. However, it is not necessary for

the grower to distinguish as closely. Such affected trees are usually unprofitable and should be removed.

It is not unlikely that the recent increase of red suture is due to a few trees in each orchard thought to be affected by borer or other environmental conditions when in reality they probably had either a severe case of borers or a combination of winter or other injuries and red suture. It is human nature to give the badly injured or subnormal tree another chance. Yet, such methods are often unprofitable and the badly injured trees rarely improve. New trees would soon surpass the old in productiveness.

Peach trees planted in the holes from which virus diseased trees were removed are not more likely to take these diseases than are any of the other trees in the orchard. Young peach trees planted as refills in old peach orchards, however, especially if the soil is sandy, are likely to fail unless due precautions are taken to prevent injury caused by the peach root aphid. This insect is often present on old peach trees. A well established tree is able to overcome the injuries of this aphid but young transplanted trees do not have enough vigor to withstand the additional drain incident to the presence of this pest. In resetting peach trees under such conditions, several practices are helpful in giving the tree a good start. Planting early is always advisable. Tamping a heavy clay soil around the roots and into the holes when planting furnishes an unfavorable environment for the root aphid. A mixture of equal parts of compost (well rotted manure or peat) and top soil, packed well into the hole around the tree is also known to help the tree become well established.

In a program of virus control, then, the grower should keep his trees in the best normal vigor, neglecting nothing in the way of insect control and never hesitating to use the axe promptly on suspicious trees.

Summary

Peach virus diseases have been known in Michigan since the advent of yellows in 1863. Little peach appeared 30 years later, and became more important than yellows. Red suture was noticed 20 years later than little peach and is now well established and scattered in localities over the western peach belt of the State. This is probably a distinct disease, different from either peach yellows or little peach. The control of these diseases lies in carefully roguing out diseased trees. The grower is advised to remove all marginal cases, to plant trees only on the best peach soil, and to keep all trees in normal vigor to facilitate diagnosis.

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